Australian Government
Great Barrier Reef Marine Park Authority

Dwarf minke whales

Information valid as of Feb 2012

Summary

Diversity

Balaenoptera acutorostrata – unnamed subspecies

Susceptibility

The food source of humpback whales in the Southern Ocean (outside of the Great Barrier Reef World Heritage Area (henceforth, the World Heritage Area)) is likely to be susceptible to impacts of climate change. The inquisitive nature of the species to vessels and people in the water during swim-with-whales tourism may lead to potential habituation of whales that may increase the risk of individuals to harmful interactions with tethers, lines and nets elsewhere and vessel strike.

Major pressures

Impacts of climate change on food resources; commercial whaling outside of the Australian Whale Sanctuary (outside the 200 nm Exclusive Economic Zone territorial limits); potential commercial marine tourism impacts.

Cumulative pressures

Cumulative impacts are of great concern as they act over space and time to apply a combined effect that is often difficult to quantify and are usually compounding. Such impacts within the Marine Park may include declining water quality from catchment run-off and coastal development. For dwarf minke whales it is considered that these pressures may impact the species over the long-term.

Management in the Great Barrier Reef and adjacent areas in Queensland

Action Plan for Australian Cetaceans, Great Barrier Reef Marine Park Act 1975; *Environment Protection and Biodiversity Conservation Act 1999*, *Nature Conservation Act 1992* (Qld); *Nature Conservation (Whales and Dolphins) Conservation Plan 1997* (Qld), and others (refer Management table, p. 8).

Existing management actions

A number of management actions are in place in the World Heritage Area that 'operationalise' legislation and provide additional guidance and/or strategic direction to Marine Park management operations. These include:

- *The Australian National Guidelines for Whale and Dolphin Watching 2005*
- *Operational Policy on Whale and Dolphin Conservation in the Great Barrier Reef Marine Park 2007 Code of Practice for dwarf minke whale interactions in the Great Barrier Reef World Heritage Area* (informed by ongoing research by James Cook University into ecologically sustainable whale watching)
- *Nature Conservation (Whales and Dolphins) Conservation Plan 1997* (Qld)
- Marine Wildlife Strandings Program (for recording and reporting stranded marine animals in Queensland)
- *Great Barrier Reef Biodiversity Conservation Strategy 2012*

Dwarf minke whale, *Balaenoptera acutorostrata* – unnamed subspecies, showing characteristic white pectoral flipper markings and dark smudge above the throat.

- *Great Barrier Reef Climate Change Action Plan 2007-2012*
- *Reef Water Quality Action Plan 2009*

***Great Barrier Reef Outlook Report 2009* assessment**

Whales in the Great Barrier Reef receive an assessment of good.[b]

Vulnerability assessment: Low

- The major concern for the larger cetaceans, especially the baleen whales that utilise the waters of the Marine Park stems from the pressure that climate change may exert upon their food resources. This pressure, for the most part, exists beyond the boundaries of the Marine Park. However, there is some evidence to support the
- Dwarf minke whales experience other pressures beyond the boundaries of the Marine Park and Australian jurisdiction that impact on the population. These include traditional hunting and commercial harvest.
- Dwarf minke whales remain a relatively cryptic species. Limited understanding of their behavioural ecology, feeding ecology, population, life-history and broader migratory patterns are key knowledge gaps that need to be addressed within the development of best-practice management.

Suggested actions to address vulnerabilities

- Support further research on the biology, diet, population, behaviour and migratory patterns and habits of dwarf minke whales.
- Continue support for the Queensland Government's Marine Wildlife Strandings Program.
- Continue to manage pressures that occur within the Marine Park that act cumulatively to impact dwarf minke whales. This is currently undertaken through the *Great Barrier Reef Biodiversity Conservation Strategy 2012*, *Great Barrier Reef Climate Change Action Plan 2007-2012* and *Reef Water Quality Action Plan 2009* in addition to initiatives such as the GBRMPA Reef Guardians program (refer to management table, p. 8).
- Continue research to assess the cumulative impacts of human interactions and further refine whale-watching and swim-with-whales policies and guidelines as part of an adaptive management approach within the Marine Park.
- Support an expansion of the current dwarf minke whales Sightings Network to properly assess the significance of human interactions within the Marine Park and adjacent waters.

[b] However, due to data deficiencies for dwarf minke whales, population trends and conservation status is unknown.

Background

Brief description of the dwarf minke whale

Taxonomy

The taxonomy of common minke whales is uncertain and is yet to be determined.[1] Rice[2] has suggested that there are three subspecies of the common minke whale: *B. acutorostrata acutorostrata* in the North Atlantic; *B. acutorostrata scammoni* in the North Pacific; and an unnamed subspecies known as the dwarf minke whale, *B. acutorostrata subsp.* occurring in the Southern Hemisphere. Bannister and colleagues[3] support the notion that the dwarf minke whale probably deserves formal subspecies status. DNA analysis has shown that the dwarf minke whale is most closely related to the Northern Hemisphere common minke whale (*B. acutorostrata acutorostrata*), rather than the Southern Hemisphere Antarctic minke whale, *B. Bonaerensis.*[4]

Migration

Little is known about the population of dwarf minke whales which visit the Great Barrier Reef each year. The taxonomic description of the subspecies found in the Great Barrier Reef remains unclear and virtually nothing is known about migration patterns of the species.[5]

While little is known about the habits of the dwarf minke sub-species, they form a well known winter aggregation in the northern Great Barrier Reef, especially in the Ribbon Reefs between Port Douglas and Lizard Island where they are the focus of a small but important swim-with-whales tourism industry, the only one of its kind in Australia.[6] A long-term photo-identification study in the northern Great Barrier Reef has shown that dwarf minke colour patterns are the most complex of all baleen whales[7] and that many individual whales are returning to the same reef location over subsequent years.[6]

There are considerable knowledge gaps regarding migratory patterns for this northern Great Barrier Reef aggregation of dwarf minke whales. As with humpback whales, this aggregation could represent the terminus of an annual migration, with the whales returning to temperate or sub-Antarctic waters for summer feeding. It is equally valid that they undertake an eastward migration and disperse through the lower latitudes of the South Pacific (M. Curnock, pers. comm, 2011). There is the further possibility that a portion of the population migrates to the south while another disperses into the South Pacific as theorised above. Although observations support these ideas they are yet to be qualified and illustrate information required for the development of informed management of the sub-species.

The dwarf minke whale is considered to be an oceanic species, however they are not restricted to deep water and have been recorded close to coasts.[3]

Age and breeding

Little is known of the life history of the dwarf minke whale, but limited data available suggests similarity with the northern common minke forms with which the dwarf minke has most taxonomic similarity.[8] Reilly and colleagues in their assessment for the International Union for Conservation of Nature (IUCN) Red List 2010 use what they consider to be an uncertain generation time of 22 years.[1] Sobtzick[9] has further refined the underwater videogrammetry methodology developed by Dunstan and colleagues as a non-lethal technique that can provide information about population demographics of whales, though study needs to be conducted over long-term time scales in order to determine these life-history characteristics.

Dwarf minke whales reach sexual maturity at about 6 m long when they are considered to be about six to eight years old.[9,10] Pregnancy rates appear to be at or near 90 per cent, suggesting an annual reproductive cycle.[8,11] This has been confirmed through resightings of females in the Great Barrier Reef with new calves in successive years.[12] It For Northern Hemisphere common minke whales, breeding is diffusely seasonal with calves appearing approximately 10 months after conception.[8] For those species, lactation lasts five to six months.[8] For southern diminutive (or dwarf) minke whales, length at birth can be approximated at 2 m.[10,11] This is also supported by sightings in the Great Barrier Reef.[5]

Small calves of dwarf minkes are recorded in Australian waters from May to July. Usually, only one or two cow and calf pairs are seen per season in northern Great Barrier Reef waters. This suggests either that these waters are not a major nursing area or that cows with calves do not regularly approach vessels there.[9,13]

Feeding

Dwarf minke whales are rorquals, the largest group of baleen whales. Rorquals feed by gulping in water, and then pushing it out through the baleen plates with their tongue to strain out organisms for food. Baleen whales, including dwarf minke whales, feed primarily on planktonic first-order consumers such as krill, and on small schooling fish species.

Baleen whales are thought to feed primarily in temperate or polar waters,[14] migrating to the Great Barrier Reef or adjacent waters during the austral winter when they usually fast and so are unaffected by the availability of food resources with the Marine Park.[15] Changes in Antarctic and temperate ecosystems, however, including changes to salinity, pH and current systems, may have profound impacts on these species by fundamentally altering these ecosystems.[16] The factors that trigger migration in baleen whales are not known. Whether or not changes in sea

surface temperature or prey availability, particularly in the Antarctic, and resultant body condition alters the migratory timing of dwarf minke and other baleen whales remains to be confirmed.[15]

The great whales, such as blue and humpback whales, undertake regular migrations between higher latitudes (where they feed) and lower latitudes (where calves are nursed). During their stay in subtropical and tropical waters, they feed little and generally thought to subsist on energy reserves laid down at high latitudes.

It is not known whether the migration of dwarf minke whales follow this pattern. They are known from sub-Antarctic waters from December to March and whales taken there have been feeding primarily on myctophid fishes (lantern fishes).[8] In a young male specimen taken incidentally in southern Brazil, a krill species (*Euphausia similis*), not previously reported in the diet of dwarf minke whales, was found to fill the contents of the animal's stomach.[17] Although it is already known that balaenopterids may feed outside their regular feeding grounds in high latitudes whenever prey is plentiful, this record of *E. similis* is the only data available on food of dwarf minke whales in mid (or low) latitudes.[17]

With their much smaller size, dwarf minke whales cannot lay down energy reserves to the extent of their larger relatives. Thus, it is suggested that while they are in the tropics they feed opportunistically in the open ocean.[18] Whilst dwarf minke whales have never been seen feeding in the northern Great Barrier Reef,[6] there are direct and indirect signs that feeding does occur in waters in or adjacent to the Marine Park (M. Curnock, pers. comm. 2012). There are preliminary indications that myctophid fish aggregations occur in the Coral Sea and there is a research aspiration to investigate their nature and if dwarf minke whales are feeding upon them (M. Curnock, pers. comm. 2012).

Speed and diving

Dwarf minkes are highly manoeuvrable and can jump from the water like a dolphin. They have been seen repeatedly circling a vessel that was cruising at 8.5 knots,[18] and have been reported keeping pace with a vessel travelling at approximately 20 knots (M. Curnock, pers. comm. 2011).

Most baleen whales are relatively shallow divers, remaining in the upper 100-200 m of water. Dwarf minke whales have been seen swimming at 20-40 m depth and one dwarf minke whale was recovered from a net set in 140 m of water off the South American coast (although it is not certain that the whale was trapped at that depth).[17]

Geographical distribution

The dwarf minke whale appears to be distributed mainly in lower latitudes of the Southern Hemisphere, but specimens have been taken as far south as 65°04'S, 178°12'E, during the summer. Its most northerly winter localities are Costinha (06°58'S) in Paraíba, Brazil; Durban, South Africa; northern Queensland, Australia; and New Caledonia.[2] It has been recorded from all states of Australia (except the Northern Territory) and in New Zealand.[3]

Between December and March, most sightings of the dwarf minke whales are in sub-Antarctic waters (58° - 60°S) to the south of Australia and New Zealand. They are occasionally found close to the ice edge (at 65°S).[19] Between March and October, dwarf minke whales are seen in the northern Great Barrier Reef, particularly in the area between Agincourt and Ribbon Reefs,[5] north of Cairns, with about 90 per cent of sightings in June and July.[12] It is unknown whether this reflects the actual abundance of the whales or only that part of the population that is more likely to interact with vessels.[18] Dwarf minke whales are also reported in very low numbers in other parts of the Great Barrier Reef south of the Ribbon Reefs area. Their large-scale movements and migration patterns when they travel to or from the Great Barrier Reef are unknown.[18]

Population status in the Great Barrier Reef Marine Park

A small population that interacts with vessels and tourists engaged in water-based activities visits the far northern section of the Great Barrier Reef each year, aggregating around the Agincourt and Ribbon Reefs area. However, it is not known what proportion of the population is represented by the interacting animals. Being a relatively cryptic species little is known of the population status of dwarf minke whales although they are not thought to be under significant pressure. Previous estimates of Southern Hemisphere common minke whale stocks have now been questioned,[8] and the International Whaling Commission's Scientific Committee is currently undertaking a new estimate.[20]

Ecosystem role/function

The dwarf minke whale is a medium-sized planktivorous (filter-feeding) cetacean. It is likely to play a role in the nutrient cycle within oceans and in maintaining the balance of trophic order.[15] Recent research[21] found that whales may significantly contribute to the productivity of the surface layer of the Southern Ocean by providing iron nutrition by defecation. Iron nutrition is required by phytoplankton for growth. This increased productivity leads to greater absorption of carbon by phytoplankton during growth.[21] This carbon is then transported to the oceans depths where it is stored.[22]

Ecosystem goods and services

Ecosystem goods and services category	Services provided by the species, taxa or habitat
Provisioning services (e.g. food, fibre, genetic resources, bio-chemicals, fresh water).	Traditionally, whale meat has been eaten by various cultures around the world. In Japan, whale meat is still considered a delicacy. Following the International Whaling Committee's (IWC) 1986 moratorium on commercial whaling, the IWC has permitted Japan to conduct a harvest of whales under provisions for scientific research. IWC regulation of this permission allows meat from this research to be sold in shops and restaurants within Japan. Japanese whaling is currently conducted by the Institute of Cetacean Research and is known to target, *inter alia*, dwarf minke whales in the Southern Ocean that may form part of the population that migrates annually to the Great Barrier Reef. Within their assessment of *B. acutorostrata* for the IUCN Redlist of Threatened Species, Reilly and colleagues[1] do not consider that the species has been subject to significant exploitation in the Southern Hemisphere. Historical uses of whale products include the use of whale blubber in the manufacture of oils and lubricants, the use of baleen for such things as buggy whips or carriage springs, and other applications where today plastic or tensile steel would be used. These uses have now been superseded or mostly outlawed.
Cultural services (e.g. spiritual values, knowledge system, education and inspiration, recreation and aesthetic values, sense of place).	Whales hold cultural significance for some coastal Indigenous Australians although there is no wider understanding on the specific significance of dwarf minke whales to Indigenous peoples within the Great Barrier Reef World Heritage Area. Aesthetic and intrinsic conservation values provide a strong social and economic impetus for the conservation of dwarf minke whales within the World Heritage Area. Cetacean watching provides significant input into the Australian economy. Dwarf minke whales form a well known winter aggregation in the Ribbon Reefs area off Port Douglas and Lizard Island where they are the focus of a small but important swim-with-whales tourism industry, the only one of its kind in Australia. Recent research has estimated that swim-with-dwarf minke whales tourism contributes several million dollars annually to the North Queensland economy.[23] For many people whales are iconic and represent symbols of inspiration or have spiritual value.
Supporting services (e.g. primary production, provision of habitat, nutrient cycling, soil formation and retention, production of atmospheric oxygen, water cycling).	The supporting services of whale species within marine ecosystems are largely unknown. Whales are likely to play a significant role in nutrient cycling in marine ecosystems. Recent research[21] found that whales may significantly contribute to the primary productivity of the surface layer of the southern ocean by providing iron nutrition by defecation. Iron nutrition is required by phytoplankton for growth. This iron is then cycled up the foodweb through krill production.[21] Further to Nicol and colleagues' work, other studies support evidence that the removal of large predators from marine ecosystems may well affect not only foodweb structure but also the seawater chemistry and physics, and thus negatively impact on the underlying primary production of the oceans.
Regulating services (e.g. invasion resistance, herbivory, seed dispersal, climate regulation, pest regulation, disease regulation, natural hazard protection, erosion regulation, water purification).	Whales are generalist top predators and may help to regulate populations of prey species and maintain ecosystem balance. The removal of top predators can also have unexpected lower order effects on non-prey species in what is referred to as trophic cascading. How whales contribute to maintaining the trophic order of marine ecosystems is largely unknown. The role which whales have been shown to perform in increasing the productivity of surface layers of temperate waters may also form a significant role in oceans carbon cycle and thus assist in climate regulation. Cold temperate waters are where a large part of the Earth's atmospheric carbon is absorbed. This process is largely assisted by the productivity of phytoplankton[22] which requires mineral iron to support growth.[21] During growth phytoplankton (predominantly diatoms) sequester then transport carbon to ocean depths.[22]

Great Barrier Reef swim-with-minke whale tourism is the only permitted in-water cetacean marine tourism in Australia.
Photo courtesy of K. Borgelt

Pressures influencing dwarf minke whales in the Great Barrier Reef Marine Park

Pressures

Baleen whales in the Great Barrier Reef, of which dwarf minke whales are one species, are thought to have fairly large and stable populations that migrate in and out of the Marine Park.[18] As with other cetaceans, the greatest threat comes from the effects that climate change will have on their ability to source food.[15] Dwarf minke whales are considered to be migratory between the Great Barrier Reef and the Southern Ocean where they conduct most of their feeding and annual conditioning. Therefore, climate change impacts that affect the food webs on which dwarf minke whales rely will occur outside the waters of the Great Barrier Reef. Whilst the Great Barrier Reef Marine Park Authority (GBRMPA) must continue to engage in processes and programs to mitigate the causes of climate change, primary focus must be given to measures that increase the resilience of dwarf minke whales to cumulative pressures experienced by the species within the Marine Park. A more detailed description of the range of pressures that impact on dwarf minke whales in the Great Barrier Reef is provided in the vulnerability assessment matrix.

Vulnerability assessment matrix

The *Great Barrier Reef Outlook Report 2009*[24] identified a number of commercial and non-commercial uses of the Marine Park, along with habitat loss and degradation as a result of climate change, coastal development and declining water quality due to catchment run off as the key pressures reducing the resilience of the ecosystem.

From the *Great Barrier Reef Outlook Report 2009*[24] it was considered that pressures such as climate change, coastal development, catchment run-off and direct use are the key factors that influence the current and projected future environmental, economic and social values of the Great Barrier Reef. These pressures can impact directly and/or indirectly on habitats, species and groups of species to reduce their resilience. Using the vulnerability assessment framework adapted by Wachenfeld and colleagues,[25] this Vulnerability Assessment aims to provide an integrated assessment of social, ecological, economic and governance information. For each key pressure in the Marine Park, exposure and sensitivity is assessed in relation to each other to reach a level of potential impact. The potential impact is then reassessed having considered the level of natural adaptive capacity that dwarf minke whales have to respond to the pressure and the adaptive capacity that management has, or can apply, to reduce the potential impact from the pressure.

This provides managers and stakeholders with an understanding of the key elements that each pressure can impose on these species to reach a final assessment of the overall residual vulnerability of dwarf minke whales to that particular pressure. This allows for the formulation of suggested actions to minimise the impact of the pressures which dwarf minke whales are most vulnerable to.

A summary of the assessment of the impacts is tabled below, however, for the detailed assessment and explanatory notes refer to Appendix 1.

Vulnerability assessment matrix summary for dwarf minke whales

		Exposed to source of pressure (yes/no)	Degree of exposure to source of pressure (low, medium, high, very high)	Sensitivity to source of pressure (low, medium, high, very high)	Adaptive capacity – natural (poor, moderate, good)	Adaptive capacity – management (poor, moderate, good)	Residual vulnerability (low, medium, high)	Level of confidence in supporting evidence (poor, moderate, good)
Pressures	**Commercial marine tourism**	Yes; regionally	Low	Low	Good	Good	Low	Moderate
	Defence activities	No	Low	Low	Good	Good	Low	Good
	Commercial fishing	No	Low	Low	Good	Good	Low	Moderate
	Recreational fishing	No	Low	Low	Good	Good	Low	Moderate
	Ports and shipping	Yes; locally (with potential for wider significance)	Low	Low	Good	Moderate	Low	Moderate
	Recreation (not fishing)	Yes; locally	Low	Low	Good	Good	Low	Moderate
	Traditional use of marine resources	No	Low	Low	Good	Good	Low	Good
	Climate change	Yes	Low (within the Marine Park)	Medium (within the Marine Park)	Poor	Poor	Medium (within the Marine Park)	Poor
	Coastal development	Yes; predominantly south of Port Douglas	Low	Low	Good	Moderate	Low	Poor
	Declining water quality due to catchment run-off	Yes; predominantly south of Cooktown	Low	Low	Good	Moderate	Low	Poor

Key concerns

- The major pressure facing marine mammals in the Marine Park comes from climate change and the related effects on their food resources. There is considerable uncertainty over what these effects will be, but they may include reduced quantity or quality and greater spatial and temporal variability of food, affecting the ability of marine mammals to adequately utilise the resource. For baleen whales, including dwarf minkes, this pressure will mainly be exerted in areas outside of the Marine Park where impacts on food resources will be most critical.
- The information on the behavioural ecology, population, life history and broader migratory patterns and habits for dwarf minke whales that travel to waters of the Great Barrier Reef is currently limited in its capacity to inform the development of appropriate management responses.
- Commercial marine tourism through swim-with-minke whale activities has the potential to expand thus exposing dwarf minke whales in the Marine Park to increased vessel numbers and in-water interactions with humans and equipment.
- There are some direct and indirect signs of dwarf minke whales feeding in waters in or adjacent to the Marine Park (M. Curnock, pers. comm, 2012). These indications may support suggestions that due to their relatively small size, dwarf minke whales may feed opportunistically throughout their migration, including in the Marine Park and adjacent Coral Sea waters.[18] If this were occurring, climate change impacts upon calcifying plankton

organisms could have long-term effects on the availability of these species.[26] Should dwarf minke whales be relying on such species in tropical latitudes to some extent, this may present dwarf minke whales with population level impacts in the long-term. Insufficient information on dwarf minke whales' habits and behaviour whilst in the World Heritage Area means that little is known of their habitat requirements whilst in the Marine Park and adjacent waters.

- As previously discussed, for baleen whales, including dwarf minkes, the effects of climate change on food resources are likely to occur well outside of the marine park. The appropriate management response is to then focus on the control of other factors that are sensitive to adjustment at the local or regional scale, such as refined tourism and visitor management, supporting the Queensland Government's Marine Wildlife Strandings Program, providing advice on programs such as the Queensland Shark Control Program and working towards the improvement of water quality and pollution levels in the World Heritage Area.

Management of dwarf minke whales in the Great Barrier Reef Marine Park

Management agencies with responsibilities for managing these species or impacts on these species within the Great Barrier Reef World Heritage Area and the statutory and non-statutory tools that influence the conservation management of these species.

Legislation or policy	Object as it applies to the species	Tools for conservation	Who administers it
World Heritage Convention	• Four natural heritage criteria with associated conditions of integrity. Criteria focus on: (i) geological processes and phenomena, including the evolution of the earth; (ii) ongoing ecological and biological processes; (iii) linked aesthetic components of the natural world; (iv) the biological diversity and habitats of threatened species • Natural heritage Criteria iv states that the natural heritage asset must contain the most important and significant natural habitats for in situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.	• Provides State Parties to the Convention with definitions of natural and cultural heritage, measures for the protection of natural and cultural heritage; the means of administration and obligations of the Convention; funding arrangements, educational programs and reporting obligations.	United Nations Educational, Scientific and Cultural Organization (UNESCO)

Convention on Biological Diversity (CBD)	• The three main objectives of the CBD are:
	  • The conservation of biological diversity
	  • The sustainable use of the components of biological diversity
	  • The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources.
		• Provides State Parties to the Convention with global principles, objectives and obligations for the conservation of biodiversity
		• Guides Australia's strategic planning to achieve national priority actions for biodiversity conservation through a range of objectives and targets for each.
			United Nations Environment Program (UNEP) – CBD Secretariat

International Union for the Conservation of Nature and Natural Resources (IUCN) Redlist of Threatened Species	• *B. acutorostrata subsp.* listed as 'Least Concern' However, this listing does not assess the dwarf minke whale as a subspecies and no population estimate for dwarf minke whales currently exists.	• Establishes the conservation status of species based on the assessment of their global population and trends • Assessment information used to formulate management response.	International Union for the Conservation of Nature and Natural Resources (IUCN)
Convention on International Trade of Endangered Species of wildlife fauna and	• *B. acutorostrata subsp.* listed in Appendix I.	• Appendix I lists species that are the most endangered among CITES-listed animals and plants	United Nations Environment Program (UNEP) –

flora (CITES)		They are threatened with extinction and CITES prohibits international trade in specimens of these species except when the purpose of the import is not commercial, for instance for scientific research.	CITES Secretariat

Bonn Convention – Convention on Migratory Species (CMS)	• Provides a basis for forming international agreement on the protection, conservation and management of migratory species
	• *B. acutorostrata* not listed.
		• The Parties to the Convention agree to:
		  • a) promote, co-operate in and support research relating to migratory species;
		  • b) endeavour to provide immediate protection for migratory species included in Appendix I; and
		  • c) endeavour to conclude Agreements covering the conservation and management of migratory species included in Appendix II
		• Animals listed as 'migratory' in appendices of the CMS are considered as matters of 'National Environmental Significance' under the *EPBC Act 1999* and are protected under the Act.
			United Nations Environment Program (UNEP) – CMS Secretariat

Action Plan for Australian Cetaceans[3]	• *B. acutorostrata subsp.* listed as 'No category assigned because of insufficient information'.	• The Plan establishes a national overview of the conservation status of Australian cetaceans and recommends conservation priorities, and research and management actions, with particular emphasis on endangered and vulnerable taxa.	Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and *Environment Protection and Biodiversity Conservation Regulations 2000*.	• Legislative framework for environmental protection in Australia • Designates all Australian Commonwealth waters as the Australian Whale Sanctuary which provides for the protection of all cetaceans • All cetaceans are protected as threatened species under the Act under the classification of 'Cetacean' • Part 8 of Regulations describes requirements for interactions with cetaceans including reporting of any interactions with marine mammals • Listing of *B. acutorostrata* as a cetacean and migratory species.	• All species on the list of migratory species are matters of national environmental significance under the EPBC Act. An action will require approval if the action has, will have, or is likely to have, a significant impact on a listed migratory species. The action must be referred to the Minister and undergo an assessment and approval process • An action affecting whales or dolphins that would otherwise be in breach of the EPBC Act could be deemed to be a 'controlled action' and require a greater scrutiny of environmental impact assessment before consideration of approval • Assessment and export approval processes for all fisheries with an export component (or Wildlife Trade Operation) that must consider interactions with threatened species • Regulates on the required reporting of any interactions with marine mammals • Penalties for non-compliance	DSEWPaC

		• Processes of review.	
Great Barrier Reef Marine Park Act 1975 and *Great Barrier Reef Marine Park Regulations 1983*	• Provides for biodiversity conservation through zoning, issuing of permits and implementation of plans of management that collectively enable management of human activities • Regulation 29, Table 29 of the Regulations provides a list of Protected Species including all cetaceans.	• Part 4A of the Regulations provides controls for human interactions with cetaceans, including whale-watching regulations • The Regulations provide for the creation of Species Conservation (Whale or Dolphin Protection) Special Management Areas • Whale Protection Areas are also described in the Regulations and implemented in Plans of Management (e.g. Whitsundays Plan of Management) (To date there is no spatial or temporal management of known dwarf minke whale aggregation sites.) • Regulation of scientific research in the Marine Park • Regulation of activities within the Marine Park • Penalties for non-compliance • Review of Act and Regulation.	Great Barrier Reef Marine Park Authority (GBRMPA)
Great Barrier Reef Marine Park Zoning Plan 2003	• A multiple-use marine protected area management tool that protects biodiversity by the regulation of activities within the Great Barrier Reef Marine Park • The Representative Area Program that provided the basis for Zoning Plan spatial planning decisions, described 70 broad-scale habitats, or bioregions and as such provides the basis for ecosystem-based management in the Marine Park.	• Spatial management of activities within the Great Barrier Reef based on protection of habitat type representative areas • Thirty-four per cent of the Marine Park is dedicated as Marine National Park (green) or Preservation (pink) zones in which no extractive activities are permitted • Restricted Access Special Management Areas (SMA) can be created for the protection of dwarf minke whales and their habitats under special circumstances • Species Conservation (dugong protection) Special Management Areas (spatial restrictions on commercial set mesh netting) subsequent protection for dwarf minke whales (e.g. Hinchinbrook Island Area) • Processes of review • Penalties for non-compliance.	GBRMPA
Operational Policy on Whale and Dolphin Conservation in the Great Barrier Reef Marine Park 2007	• The objective of the policy is to provide a framework for the conservation of whales and dolphins by partnering with reef users and managing their activities within the Great Barrier Reef Marine Park • This operational policy implements the GBRMPA's obligations under the Australian Government's *Australian National Guidelines for Whale and Dolphin Watching 2005.*	• Policy reviewed on regular basis in line with changes to legislation and national guidelines • Provides basis for public education • Penalties for non-compliance under the *Great Barrier Reef Marine Park Act 1975.*	GBRMPA
Code of Practice for dwarf minke whale	• This Code of Practice provides information for any person likely	• This Code of Practice outlines the environmentally responsible	GBRMPA

interactions in the Great Barrier Reef World Heritage Area[27]	to be involved in an encounter with a dwarf minke whale whilst in the Marine Park, in particular swimming-with-whales endorsed tourism operators and their passengers.	way to approach and interact with dwarf minke whales. It has been developed specifically for the permitted tourism operators with an endorsement for swimming-with-whales in the Marine Park, and it incorporates existing legal requirements.	
Queensland Nature Conservation Act 1992 and *Nature Conservation (Wildlife) Regulation 2006*	• Provides for the protection of marine mammals including whales • Reporting on interactions with protected marine mammals is regulated and annual reports on cetacean strandings and mortality are compiled.	• Provides legislative requirement for the development of conservation plans • Strandings mortality and interaction data are used for scientific research and to compile policies and position statements • Penalties for non-compliance • Processes of review.	Queensland Government
Nature Conservation (Whales and Dolphins) Conservation Plan 1997 (Qld)	• Development of management intent for whales and dolphins in Queensland and adjacent waters.	• Management framework for cetacean watching activities, protection and conservation, monitoring of populations, review of management tools, research, and collaborative approaches to management • Penalties for non-compliance • Processes of review.	Queensland Government
Marine Wildlife Stranding Program	• Collects and reports on stranding and mortality information of threatened marine wildlife species within Queensland.	• Provides critical information to aid and inform research and management initiatives • Processes of review.	Queensland Government (jointly funded by the GBRMPA through the Field Management Program)
Queensland Shark Control Program (QSCP)	• Community Education and Protection Policy under *Fisheries Act* (Qld) *1994* • 35 nets at localities in Cairns, Mackay, Rainbow Beach, Sunshine Coast, and the Gold Coast • 344 drumlines at localities across Cairns, Townsville, Mackay, Capricorn Coast, Gladstone, Bundaberg, Rainbow Beach, Sunshine Coast, North Stradbroke Island and the Gold Coast.[28]	• Nets designed to capture sharks greater than 2 m in length. Nets are 186 m long. Most nets have a depth of 6 m and a mesh size of 500 mm • Ten remaining shark nets in the Great Barrier Reef: five off Cairns beaches; five off Mackay beaches • Drumline arrays consist of up to six or more shark hooks with fresh bait suspended individually from large plastic floats. (Roughly one net = six drumlines) • Equipment checked every second day, weather permitting • The use of audible 'pingers' on shark nets are being trialled in an effort to prevent dolphin entanglement • Other measures employed to reduce interactions with threatened species • Processes of review.	Queensland Government
Great Barrier Reef Biodiversity Conservation Strategy 2012	• Identifies dwarf minke whales as a species 'at risk' in the Marine Park • Grades the level of risk experienced by dwarf minke	• The Biodiversity Conservation Strategy outlines a Framework for Action with three strategic objectives aimed at building or maintaining ecosystem resilience	GBRMPA

	whales through a vulnerability assessment process.	and protecting biodiversity: 1. Engage communities and foster stewardship 2. Building ecosystem resilience in a changing climate 3. Improved knowledge • Objectives are comprised of program-level outcomes with key actions and contain targets for measuring success • Implementation of the Strategy will be undertaken through a multi–agency, multi-stakeholder collaborative approach.	
Great Barrier Reef Climate Change Action Plan 2007-2012	• Identification of specific measures to enhance resilience of the Great Barrier Reef ecosystem and support adaptation by regional communities and industries that depend on it.	• Allocation of dedicated funding to implement actions to improve the resilience of the Great Barrier Reef ecosystem.	GBRMPA
Reef Water Quality Protection Plan 2009	• An overarching framework to achieve a sustainable future for the Great Barrier Reef and the industries in the Reef's catchment by improving water quality that flows into the Great Barrier Reef lagoon.	• Improve water quality that flows into the Reef by targeting priority outcomes, integrating industry and community initiatives and incorporating new policy and regulatory frameworks.	Joint Australian Government and State of Queensland initiative
Great Barrier Reef Protection Amendment Act 2009 (Qld)	• A framework for reducing the levels of dangerous pesticides and fertilisers found in the waters of the Great Barrier Reef by 50 per cent in four years.	• Mix of strict controls on farm chemicals and regulations to improve farming practices.	Queensland Government
Coastal Protection and Management Act 1995 (Qld) and *Coastal Protection and Management Regulation 2003*	• Provides the legislative framework and regulations for the coordinated management of the diverse range of coastal resources and values in the coastal zone. This framework includes provisions that establish the Queensland Coastal Plan.	• Queensland Coastal Plan outlines directions for effective protection and management of the coastal zone.	Queensland Government
Queensland Coastal Plan (prepared under the *Coastal Protection and Management Act 1995* and includes a state planning policy under the *Sustainable Planning Act 2009*)	• The Queensland Coastal Plan has two parts: State Policy for Coastal Management and the State Planning Policy 3/11: Coastal Protection (SPP).	• The State Policy for Coastal Management provides policy direction for natural resource management decision-makers about land on the coast, such as coastal reserves, beaches, esplanades and tidal areas • The SPP provides policy direction and assessment criteria to direct land-use planning and development assessment decision making under the *Sustainable Planning Act 2009*.	Queensland Government
Sustainable Planning Act 2009 (Qld) and *Sustainable Planning Regulation 2009*	• Establishes process for land-use planning and development assessments. Identifies state legislation that may be triggered by development assessments and the process by which developments must be assessed against each piece of legislation • Establishes the framework for the development of regional plans.	• Regional plans operate in conjunction with other state planning instruments, usually taking precedence over them • Regional plans must conform to policies established within the Queensland Coastal Plan • Regional plans identify: • desired regional outcomes • policies and actions for	Queensland Government

		achieving these desired regional outcomes • the future regional land-use pattern • regional infrastructure provision to service the future regional land-use pattern • key regional environmental, economic and cultural resources to be preserved, maintained or developed.	

References

1. Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell, R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. & Zerbini, A.N. 2010, *Balaenoptera acutorostrata: IUCN red list of threatened species,* IUCN, International Union for Conservation of Nature, viewed 01/03/2011, <http://www.iucnredlist.org/apps/redlist/details/2474/0> .

2. Rice, D.W. 1998, *Marine mammals of the world: systematics and distribution,* Allen Press, Lawrence, KS.

3. Bannister, J.L., Kemper, C.M. and Warneke, R.M. 1996, *The action plan for Australian cetaceans,* Australian Nature Conservation Agency, Canberra, viewed 01/03/2011, <http://www.environment.gov.au/coasts/publications/cetaceans-action-plan/pubs/whaleplan.pdf>.

4. Pastene, L.A., Fujise, Y. and Numachi, K. 1994, Differentiation of mitochondrial DNA between ordinary and dwarf forms of southern minke whale, *Reports of the International Whaling Commission* 44: 277-282.

5. Arnold, P.W. 1997, Occurrence of Dwarf Minke whales (*Balaenoptera acutorostrata*) on the Northern Great Barrier Reef, Australia, *Reports of the International Whaling Commission* 47: 419-424.

6. Birtles, R.A., Arnold, P.W. and Dunstan, A. 2002, Commercial swim programs with dwarf minke whales on the northern Great Barrier Reef, Australia: some characteristics of the encounters with management implications, *Australian Mammalogy* 24(1): 23-38.

7. Arnold, P.W., Birtles, R.A., Dunstan, A., Lukoschek, V. and Matthews, M. 2005, Colour patterns of the dwarf minke whale *Balaenoptera acutorostrata* sensu lato: description, cladistic analysis and taxonomic implications, *Memoirs of the Queensland Museum* 51: 277-307.

8. Perrin, W.F. and Brownell, R.L. 2009, Minke Whales: *Balaenoptera acutorostrata* and *B. bonaerensis*, in *Encyclopedia of marine mammals*, eds W.F. Perrin, B. Würsig and J.G.M. Thewissen, 2nd edn, Academic Press, Burlington, MA, pp. 733-735.

9. Sobtzick, S. 2011, *Dwarf minke whales in the northern Great Barrier Reef and implications for the sustainable management of the swim-with whales industry,* PhD thesis, James Cook University, Townsville.

10. Best, P.B. 1985, External characters of southern minke whales and the existence of a diminuitive form, *Scientific Reports of the Whales Research Institute* 36: 1-33.

11. Arnold, P., Marsh, H. and Heinsohn, G.E. 1987, The occurrence of two forms of minke whales in east Australian waters with a description of external characteristics and skeleton of the diminutive or dwarf form, *Scientific Reports of the Whales Research Institute* 38: 1-46.

12. Birtles, R.A., Valentine, P., Curnock, M., Mangott, A., Sobtzick, S. and Marsh, H. 2010, *Dwarf minke whale tourism monitoring program (2003 - 2008) unpublished draft,* James Cook University, Townsville.

13. Dunstan, A., Sobtzick, S., Birtles, R.A. and Arnold, P.W. 2007, Use of videogrammetry to estimate length to provide population demographics of dwarf minke whales in the northern Great Barrier Reef, *Journal Cetacean Research and Management* 9(3): 215-223.

14. Bannister, J.L. 2009, Baleen Whales (Mysticetes) , in *Encyclopedia of marine mammals*, eds W.F. Perrin, B. Würsig and J.G.M. Thewissen, 2nd edn, Academic Press, Burlington, MA, pp. 80-89.

15. Lawler, I.R., Parra, G.J. and Noad, M. 2007, Vulnerability of marine mammals in the Great Barrier Reef to climate change, in *Climate change and the Great Barrier Reef: a vulnerability assessment*, eds J.E. Johnson and P.A. Marshall, Great Barrier Reef Marine Park Authority and Australian Greenhouse Office, Townsville, pp. 497-513, viewed 01/03/2011, <http://www.gbrmpa.gov.au/__data/assets/pdf_file/0013/5431/chpt-16-lawler-et-al-2007.pdf>.

16. Learmonth, J.A., MacLeod, C.D., Santos, M.B., Pierce, G.J., Crick, H.Q.P. and Robinson, R.A. 2006, Potential effects of climate change on marine mammals, *Oceanography and Marine Biology: An Annual Review* 44: 431-464.

17. Secchi, E.R., Barcellos, L., Zerbini, A.N. and DallaRosa, L. 2003, Biological observations on a dwarf minke whale, *Balaenoptera acutorostrata*, caught in southern Brazilian waters, with a new record of prey for the species, *Latin American Journal of Aquatic Mammals* 2(2): 109-115.

18. CRCReefResearchCentre 2002, *Dwarf minke whales in the Great Barrier Reef: current state of knowledge*, CRC Reef Research Centre, Cairns.

19. Acevedo, J., Olavarría, C., Plana, J., Aguayo-Lobo, A., Larrea, A. and Pastene, L.A. 2011, Occurrence of dwarf minke whales (*Balaenoptera acutorostrata* subsp.) around the Antarctic Peninsula, *Polar Biology* 34: 1-6.

20. International Whaling Commission 2010, *Whale population estimates,* International Whaling Commission, viewed 01/03/2011, <http://www.iwcoffice.org/conservation/estimate.htm> .

21. Nicol, S., Bowie, A., Jarman, S., Lannuzel, D., Meiners, K.M. and Van Der Merwe, P. 2010, Southern Ocean iron fertilization by baleen whales and Antarctic krill, *Fish and Fisheries* 11(2): 203-209.

22. Whiteley, M. 2003, *The influence of Antarctic krill (Euphausia superba) on carbon fluxes in the Southern Ocean,* Honours dissertation, University of Western Australia, Perth.

23. Stoeckl, N., Birtles, A., Farr, M., Mangott, A., Curnock, M. and Valentine, P. 2010, Live-aboard dive boats in the Great Barrier Reef: regional economic impact and the relative values of their target marine species, *Tourism Economics* 16(4): 995-1018.

24. Great Barrier Reef Marine Park Authority 2009, *Great Barrier Reef Outlook Report 2009,* Great Barrier Reef Marine Park Authority, Townsville, viewed 01/03/2011, <http://www.gbrmpa.gov.au/__data/assets/pdf_file/0018/3843/OutlookReport_Full.pdf>.

25. Wachenfeld, D., Johnson, J., Skeat, A., Kenchington, R., Marshall, P.A. and Innes, J. 2007, Introduction to the Great Barrier Reef and climate change, in *Climate change and the Great Barrier Reef: a vulnerability assessment*, eds J.E. Johnson and P.A. Marshall, Great Barrier Reef Marine Park Authority and the Australian Greenhouse Office, Townsville, pp. 1-14, viewed 01/03/2011, <http://www.gbrmpa.gov.au/__data/assets/pdf_file/0014/4442/chpt-1-wachenfeld-et-al-2007.pdf>.

26. Richardson, A.J., McKinnon, D. and Swadling, K.M. 2009, Zooplankton, in *Report card of marine climate change for Australia 2009*, eds E.S. Poloczanska, A. Hobday and A.J. Richardson, National Climate Change Adaptation Research Facility, Southport, pp. 156-170.

27. Birtles, R.A., Arnold, P., Curnock, M., Salmon, S., Mangott, A., Sobtzick, S., Valentine, P., Caillaud, A. and Rumney, J. 2008, *Code of Practice for dwarf minke whale interactions in the Great Barrier Reef World Heritage Area,* Great Barrier Reef Marine Park Authority, Townsville.

28. Department of Primary Industries and Fisheries 2006, *A report on the Queensland Shark Safety Program,* Department of Primary Industries and Fisheries, Brisbane, viewed 01/03/2011, <http://www2.dpi.qld.gov.au/extra/pdf/fishweb/sharksafetyreport.pdf>.

29. Curnock, M. 2011, *Mechanisms for assessing the sustainability of swimming-with-whales tourism in the Great Barrier Reef,* PhD thesis, James Cook University, Townsville.

30. Mangott, A.H. 2010, *Behaviour of dwarf minke whales (Balaenoptera acutorostrata subsp.) associated with a swim-with industry in the northern Great Barrier Reef,* PhD thesis, James Cook University, Townsville.

31. O'Neill, P. 2009, Marine fauna, in *State of the Environment report for Shoalwater Bay Training Area 2008* Department of Defence, Canberra.

32. Hutchings, P.A., Haynes, D., Goudkamp, K. and McCook, L. 2005, Catchment to reef: water quality issues in the Great Barrier Reef Region—an overview of papers, *Marine Pollution Bulletin* 51(1-4): 3-8.

33. Department of Employment, Economic Development and Innovation 2009, *Queensland Fisheries Strategy 2009-2014,* Department of Employment, Economic Development and Innovation, Brisbane, viewed 01/03/2011, <http://www.dpi.qld.gov.au/documents/Fisheries_PolicyAndLegislation/Qld-Fisheries-Strategy-09to14.pdf>.

Appendix 1. Vulnerability assessment matrix

	Pressures									
	Commercial marine tourism	**Defence activities**	**Commercial fishing**	**Recreational fishing**	**Ports and shipping**	**Recreation (not fishing)**	**Traditional use of marine resources**	**Climate change**	**Coastal development**	**Declining water quality due to catchment run-off**
Exposed to source of pressure **(yes/no)**	Yes*; regionally	Yes; locally	No	No	Yes; locally (with potential for wider significance)	Yes; locally	No	Yes	Yes*; predominantly south of Port Douglas	Yes*; predominantly south of Cooktown
Degree of exposure to source of pressure **(low, medium, high, very high)**	Low. Exposure of dwarf minke whales to impacts from commercial tourism in the Marine Park is focused around the seasonal aggregations in the northern Great Barrier Reef. The impacts from interactions with tour operations may extend beyond the spatial area over which the pressure is directly applied but may only apply to a few individuals that display habituation behaviour.	Low. At the local scale, dwarf minke whales may be exposed to defence activities. Defence activities are restricted spatially and mostly concentrated in coastal waters in the Great Barrier Reef Region. Exposure is considered low, as the species is predominantly oceanic and there is minimum overlap with where Defence conducts exercises.	Low. Dwarf minke whales are not considered to be exposed to commercial fishing pressures within the Great Barrier Reef Region.	Low. Dwarf minke whales are not considered to be exposed to recreational fishing pressures within the Great Barrier Reef Region.	Low. Dwarf minke whales are predominantly an oceanic species that sometimes frequent the coastal zone. This may expose them to the possibility of being struck by shipping vessels in high traffic localities such as port entrances and shipping lanes. The exposure to this threat is low. Exposure to pollution incident impacts is considered low risk.	Low. Although the human population will increase along the Great Barrier Reef coast in the coming years, most opportunities to interact with dwarf minke whales exists in the more remote areas of the Great Barrier Reef Region that are not easily accessible to most of the population.	Low. There is no known traditional use of dwarf minke whales in Australia.	Low (within the Great Barrier Reef Marine Park). The major pressure on dwarf minke whales from the impacts of climate change are related to effects on their food resources outside the Great Barrier Reef Region. There is considerable uncertainty over what these effects will be, but they may include reduced quantity or quality and greater spatial and temporal variability of food, affecting the ability of dwarf minke whales to adequately provision themselves. For dwarf minke whales, and indeed all baleen whales that migrate to the Great Barrier	Low. When assessed independently, the exposure of dwarf minke whales to the pressure of coastal development in the discernable future is not considered to be high as the species is not thought to rely on inshore or reefal habitats, nor are they reliant upon prey species known to be susceptible to coastal development pressures.	Low. When assessed independently, the exposure of dwarf minke whales to the pressure of declining water quality due to catchment run-off in the discernable future is not considered to be high as the species is not thought to rely on inshore or reefal habitats, nor are they reliant upon prey species known to be susceptible to this pressure.

	Pressures									
	Commercial marine tourism	**Defence activities**	**Commercial fishing**	**Recreational fishing**	**Ports and shipping**	**Recreation (not fishing)**	**Traditional use of marine resources**	**Climate change**	**Coastal development**	**Declining water quality due to catchment run-off**
								Reef, the effects of climate change on food resources are most likely to occur well outside of the Marine Park.		
Sensitivity to source of pressure **(low, medium, high, very high)**	Low. Dwarf minke whale sensitivity to disturbance from targeted tourism operations is unknown due to limited knowledge on biology, population, behavioural ecology, migration behaviour, and the full function of known aggregation sites in the northern Great Barrier Reef Region. Research suggests that direct sensitivity may be low. It is unclear how tourism interactions disrupt normal behaviours. Individual whales exhibit behaviours that indicate they have become habituated to swimmers involved with the swim-with-whales activity. Re-sighted whales are more likely to approach swimmers more closely than new whales and	Low. Cetaceans can demonstrate altered behaviour in the presence of vessel traffic. Explosion of underwater ordnance could cause permanent damage to hearing organs leading to possible starvation and death if the animal were in the immediate vicinity. However, due to their low exposure to this pressure and the mobility and manoeuvrability of dwarf minke whales, their sensitivity to defence activities is considered low.	Low. Dwarf minke whales are not considered to be affected by commercial fishing so sensitivity to this pressure is considered low.	Low. Dwarf minke whales are not considered to be exposed or sensitive to fishing pressures within the Great Barrier Reef Region.	Low. Due to their low exposure to this pressure and the mobility and manoeuvrability of dwarf minke whales, their sensitivity to ports and shipping pressures is considered to be low.	Low. Due to their low exposure to this pressure, dwarf minke whales' sensitivity to recreation pressures is considered to be low.	Low. Dwarf minke whales are not considered to be exposed or sensitive to traditional use of marine resource pressures within the Great Barrier Reef Region.	Medium (within the Great Barrier Reef Marine Park). It has been suggested that due to their small size and inability to store significant reserves of energy, dwarf minke whales may feed opportunistically within the Marine Park and the adjacent Coral Sea.[18] Although this is not entirely understood, if dwarf minke whales were reliant on food resources within the Marine Park or adjacent waters, sensitivity to climate change impacts upon possible food resources within the Great Barrier Reef Region could be significant in the long-term (for example, if the Marine Park they	Low. Due to the low exposure of dwarf minke whales to this pressure and as current knowledge indicates that coastal development will have no impact on growth of the population, sensitivity to coastal development is low. Thresholds of cumulative pressures (of climate change, coastal development and declining water quality due to catchment run-off) that may impact dwarf minke whales in the long-term are unknown.	Low. Due to the low exposure of dwarf minke whales to this pressure and as current knowledge indicates that coastal development will have no impact on growth of the population, sensitivity to coastal development is low. Thresholds of cumulative pressures (of climate change, coastal development and declining water quality due to catchment run-off) that may impact dwarf minke whales in the long-term are unknown.

	Pressures									
	Commercial marine tourism	**Defence activities**	**Commercial fishing**	**Recreational fishing**	**Ports and shipping**	**Recreation (not fishing)**	**Traditional use of marine resources**	**Climate change**	**Coastal development**	**Declining water quality due to catchment run-off**
	whales have also been shown to decrease their approach distances during the season. Behaviours learnt during interactions with the swim-with-whales tourism that may predispose them to interactions with other set or tethered gear deployed in the Great Barrier Reef Region. Marine animal strandings data provides no indication that this is currently occurring.							were feeding upon calcifying plankton, climate change impacts on ocean acidification is likely to affect the abundance of these prey species[26]). Dwarf minke whale sensitivity to climate change impacts within the Marine Park is unknown due to limited knowledge on biology, population, behavioural/ feeding ecology, migration behaviour, and the full function of known aggregation sites in the northern Great Barrier Reef Region.		
Adaptive capacity – natural **(poor, moderate, good)**	Good. Dwarf minke whales initiate interactions with vessels and swimmers by approaching vessels and then swimmers when they are in the water. Data indicates that individual whales modify their behaviour when exposed to the swim-with-whales	Good. In consideration of the low levels of exposure and sensitivity to this pressure in the Marine Park, and that the main habitat used by dwarf minke whales in the Great Barrier Reef is geographically separated from	Good. Dwarf minke whales have the capacity to avoid commercial fishing operations should they occur in habitats utilised by this species. Should commercial fishing operations be conducted in the vicinity of	Good. With the level of ecological knowledge that does exist on dwarf minke whales, recreational fishing in the Great Barrier Reef is not expected to impact on the stability of the dwarf minke	Good. In consideration of the levels of exposure and sensitivity to this pressure and due to the mobility and manoeuvrability of dwarf minke whales, their adaptive capacity to shipping pressures is	Good. Adaptive capacity to increased visitor disturbance is unknown due to limited knowledge on biology, population, behavioural ecology, migration behaviour, and	Good. Due to no pressure from this source, dwarf minke whales are not assessed for their adaptive capacity to traditional use.	Poor. Pressures upon dwarf minke whales from climate change will mostly be exerted upon their food resources that exist well outside the Great Barrier Reef. Habitat and trophic specificity with regards to their foraging	Good. Due to low exposure and sensitivity to this pressure, dwarf minke whales are not expected to require a natural adaptive capacity to it. Natural adaptive capacity is therefore set at good.	Good. Due to low exposure and sensitivity to this pressure, dwarf minke whales are not expected to require a natural adaptive capacity to it. Natural adaptive capacity is therefore set at good.

	Pressures									
	Commercial marine tourism	**Defence activities**	**Commercial fishing**	**Recreational fishing**	**Ports and shipping**	**Recreation (not fishing)**	**Traditional use of marine resources**	**Climate change**	**Coastal development**	**Declining water quality due to catchment run-off**
	activity, but there are no data on the impact or energetic costs of these interactions. However, given that there is data indicating whales being re-sighted over several seasons their adaptive capacity is considered to be good. It is expected that should animals feel threatened they are likely to interact less with tourism boats and swim-with-whales activities.	where defence activities occur, the adaptive capacity to defence activity pressures is considered to be good.	areas that dwarf minkes habituate, there would be concerns as to whether the interacting population would be drawn to fishing vessels, not disturbed by them.	whale population that migrates into the Marine Park.	considered to be good.	the full function of known aggregation sites in the northern Great Barrier Reef Region. However, due to the remoteness of known aggregation sites, disturbance from recreational activities is considered to be low.		requirements translates to a poor adaptive capacity to food resource shortage within their primary foraging grounds. If dwarf minke whales were relying on opportunistic feeding upon planktonic species in the Marine Park impacted on by climate change and increasing ocean acidity, this population may not be able to adapt well to such pressure.		
Adaptive capacity – management **(poor, moderate, good)**	Good. There is ongoing research into the ecological sustainability of dwarf minke swim-with-whales tourism to better inform management. This information will inform any future considerations of management arrangements for this activity and can be incorporated into GBRMPA policy and the Code of Practice for dwarf minke whale interactions in	Good. Defence activities are well managed and limited in extent, duration and geographic distribution. Further spatial and temporal management could be considered if required.	Good. In consideration of the exposure and sensitivity of dwarf minke whales to fishing pressures, there is currently little adaptive management input required.	Good. In consideration of the exposure and sensitivity of dwarf minke whales to fishing pressures, there is currently little adaptive management input required.	Moderate. The GBRMPA has strategies and statutory tools to lower the risk of vessel-related oil spills and pollution incidents. However, the risks can only be lowered and not eliminated.	Good. There is a well established policy and legislative framework that regulates interactions between Marine Park users and whales and dolphins. These management tools have been developed based on national guidelines and reviews of the status of	Good. Ongoing low exposure to this source of pressure requires little adaptive management input.	Poor. Options for local or regional scale management of climate impacts on dwarf minke whales remain very limited because most impacts are directly linked to large-scale global climate phenomena rather than more local threatening processes. Current available information on	Moderate. The *Great Barrier Reef Marine Park Act 1975* provides limited scope to manage activities outside the Marine Park. To achieve good water quality and coastal ecosystem outcomes for the Great Barrier Reef, the GBRMPA facilitates the development of partnerships with industry, the	Moderate. The *Great Barrier Reef Marine Park Act 1975* provides limited scope to manage activities outside the Marine Park. To achieve good water quality and coastal ecosystem outcomes for the Great Barrier Reef, the GBRMPA facilitates the development of partnerships with

	Pressures									
	Commercial marine tourism	**Defence activities**	**Commercial fishing**	**Recreational fishing**	**Ports and shipping**	**Recreation (not fishing)**	**Traditional use of marine resources**	**Climate change**	**Coastal development**	**Declining water quality due to catchment run-off**
	the Great Barrier Reef World Heritage Area.					cetacean species of conservation concern. These processes are dynamic and are open for review as new information on best practice is developed in line with new information from targeted science. GBRMPA public education and stewardship programs are well developed and can be adapted as required.		climate change impacts on dwarf minke whales is being implemented into developing management actions within the World Heritage Area. The GBRMPA's current framework for managing climate change impacts has been developed to implement new information as it becomes available.	community, local and state government and other Australian Government agencies to influence the management and planning of catchment and coastal pressures, developing and maintaining a culture of mutual obligation. This is undertaken by providing input into the Queensland Coastal Plan policies and statutory Regional Plans which plan for coastal development in Queensland. The *Sustainable Planning Act 2009* (Qld) legislates on state planning approval processes and requires triggered proposals to be assessed under considerations such as the *Fisheries Act 1994* habitat management capabilities.	industry, the community, local and state government and other Australian Government agencies to influence the management and planning of catchment and coastal pressures, developing and maintaining a culture of mutual obligation. This is undertaken by fostering partnerships through the *Reef Water Quality Protection Plan 2009* and *Reef Rescue Program*.

	Pressures									
	Commercial marine tourism	**Defence activities**	**Commercial fishing**	**Recreational fishing**	**Ports and shipping**	**Recreation (not fishing)**	**Traditional use of marine resources**	**Climate change**	**Coastal development**	**Declining water quality due to catchment run-off**
									The GBRMPA also provides input into environmental assessments for projects referred under the EPBC Act.	
Residual vulnerability **(low, medium, high)**	Low	Low	Low	Low	Low	Low	Low	Medium (within the Marine Park)	Low	Low
Level of confidence in supporting evidence **(poor, moderate, good)**	Moderate. Birtles *et al*. 2010,[12] Birtles *et al*. 2002,[6] Curnock 2011,[29] Sobtzick 2011,[9] Mangott 2010,[30] Stoeckl 2010,[23] CRC Reef Research Centre 2002.[18]	Good. O'neill 2009.[31]	Moderate. CRC Reef Research Centre 2002.[18]	Moderate. CRC Reef Research Centre 2002.[18]	Moderate. CRC Reef Research Centre 2002.[18]	Moderate. Birtles *et al*. 2010,[12] CRC Reef Research Centre 2002.[18]	Good. Strong anecdotal evidence suggests no known traditional use of dwarf minke whales.	Poor. Lawler *et al*. 2007,[15] Learmonth *et al*. 2006.[16]	Poor. Unknown.	Poor. Unknown. Hutchings *et al*. 2005.[32]

The pressures addressed in this Vulnerability Assessment were identified in the *Great Barrier Reef Outlook Report 2009.*[24]

* Coastal habitats (rivers, estuaries, seagrasses, mangroves and wetlands) are under increasing pressure from human activities. More than 85 per cent of Queensland's population live on the coastal fringe. Predicted strong population growth means that the intensity of activity and development in coastal zones is likely to persist.[33]

The purpose of the vulnerability assessment process is to provide a mechanism to highlight key concerns and make assessments of the vulnerabilities that species, groups of species or habitats have to known sources of pressure within the Great Barrier Reef World Heritage Area (the World Heritage Area) using a standardised and transparent process. This was undertaken using a standard approach to assess exposure and sensitivity and adaptive capacity to potential impacts (Figure 1) based on the best-available information on that particular habitat, species or group of species.

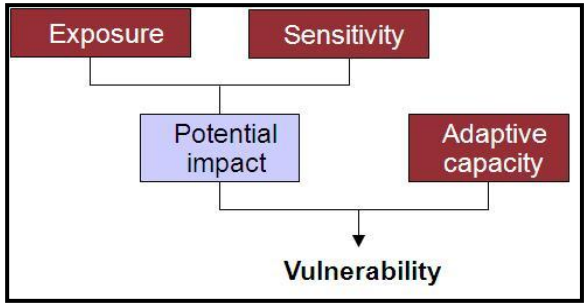

Figure 1. The key components of vulnerability assessments (Adapted from Wachenfeld *et al*., 2007)

To achieve this objective it has been necessary to apply a linear relationship to comparisons that are sometimes non-linear by nature. For example, when applying the potential impact matrix[c] to create a combined score for exposure and sensitivity, if a species, group of species or habitat has a very high level of exposure to a pressure but low sensitivity to it, it is scored as having a medium-high potential impact score. This medium-high score may be the same as determined for another assessment where there may be a low level of exposure but a very high level of sensitivity. This implies a linear relationship for the sensitivity a species or habitat has to a given level of exposure, which may not necessarily be the case. However, it does provide managers with the required level of resolution on these relationships for the purpose of the vulnerability assessments that inform the *Great Barrier Reef Biodiversity Conservation Strategy 2012*.

The methods used to determine the degree of exposure or sensitivity of dwarf minke whales of the World Heritage Area against each source of pressure are described within the vulnerability assessments page of the GBRMPA website.

The natural capacity of dwarf minke whales to adapt to pressures in the Great Barrier Reef, and the capacity of management to intervene (which in turn may assist dwarf minke whales to adapt to these pressures), are considered as two dynamics that affect their residual vulnerability to any of the identified pressures. These two dynamics are then combined to produce an overall rating for adaptive capacity and then applied to the potential impact rating to provide a score for the residual vulnerability that dwarf minke whales may be expected to experience for the given pressure. An explanation of the procedure by which this process has been applied and qualifying statements for the assessment of adaptive capacity (natural and management) scores are provided within the vulnerability assessments page of the GBRMPA website.

Published by the Great Barrier Reef Marine Park Authority

ISBN 978 1 921682 59 9 (pdf)

[c] The potential impact matrix is described within the vulnerability assessments page of the GBRMPA website.